Center Innovation Fund: GSFC CIF

Innovative Techniques for Micro-scale Additive Manufacturing for Sensors (µAM)

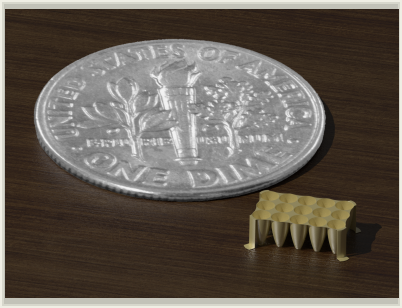
Completed Technology Project (2015 - 2017)

Project Introduction

The field of additive manufacturing with real materials (such as metals) has evolved from 3D printing of plastics. The primary approach uses powder bed fusion (described below). Because there is a practical limit to how small the powder grains can be, there is a lower limit on the resolution of the items created. Also, the process only works on materials that can be fused or sintered by a laser or electron beam. The primary purpose of this micro-scale additive manufacturing effort is to develop a new method of additive manufacturing capable of much higher resolution and the ability to work with many materials that are not compatible with the powder bed fusion process.

A thin, uniform layer of a powder is spread out on a platen, then a powerful laser beam or electron beam is scanned over the powder film. Where the bean is turned on, the power is fused together. Then another layer is spread out over the previous one and the process is repeated. New layers are continually added and fused building up a fused shape surrounded by loose powder. The loose powder acts as scaffolding, supporting voids and overhangs. Once the shape is completed, the loose powder is shaken loose, leaving the final part. The size of the powder grains is the primary limit on resolution. Typically, this is about 0.004 (4/1000) inches or 100 microns (a micron is 1/1000th of a millimeter). As you make a powder grain smaller, the weight decreases as the volume. Since the volume changes by the cube of the dimension, while the area decreases by the square, as you make the grains smaller, the surface to volume ratio increases. As the surface to volume ratio increases, gravity becomes less important, while sensitivity to air movement or static electricity increases. So, the practical lower limit to the size of the powders grains is a few thousands of an inch. Clearly for really small things, like the nanobots you see in movies, you need a different approach. That's what the micro-scale additive manufacturing project is all about. We are working to develop a new additive manufacturing process that can produce parts with 30 to 100 times higher resolution that is compatible with metals and many materials that can't be used with the powder bed fusion approach. Since this is a brand new approach, the first year we will work on demonstrating the process on normal size objects. Once we have the process under control, during the second year we plan to create objects from metals and other "real" materials with resolutions 10 to 30 times finer than is possible with the powder bed fusion method. Eventually, this process should be able to create structures with feature just a few wavelengths of visible light across! Imagine a complete micro-thruster the size of a grain of rice.

This project plans to demonstrate a technology capable of producing parts by additive manufacturing with a much higher resolution than current processes--eventually 100X or more.



Micro-Cone Array

Table of Contents

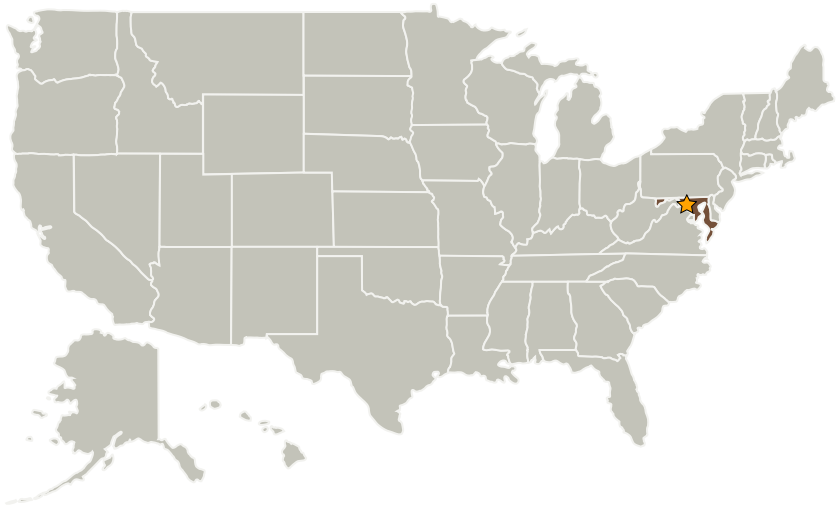
Innovative Techniques for Micro-scale Additive Manufacturing for Sensors (µAM)

Completed Technology Project (2015 - 2017)

Anticipated Benefits

N/A

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Project Transitions

October 2015: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Innovation Fund: GSFC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

Peter M Hughes

Project Manager:

Terence A Doiron

Principal Investigator:

Vincent T Bly

Center Innovation Fund: GSFC CIF

Innovative Techniques for Micro-scale Additive Manufacturing for Sensors (µAM)

Completed Technology Project (2015 - 2017)

September 2017: Closed out

Closeout Summary: The purpose of the Goddard Space Flight Center's Internal Research and Development (IRAD) program is to support new technology development and to address scientific challenges. Each year, Principal Investigators (PIs) submit IRAD proposals and compete for funding for their development projects. Goddard's IRAD program supports eight Lines of Business: Astrophysics; Communications and Navigation; Cross-Cutting Technology and Capabilities; Earth Science; Heliophysics; Planetary Science; Science Small Satellites Technology; and Suborbital Platforms and Range Services.Task progress is evaluated twice a year at the Mid-term IRAD review and the end of the year. When the funding period has ended, the PIs compete again for IRAD funding or seek new sources of development and research funding or agree to external partnerships and collaborations. In some cases, when the development work has reached the appropriate Technology Readiness Level (TRL) level, the product is integrated into an actual NASA mission or used to support other government agencies. The technology may also be licensed out to the industry.The completion of a project does not necessarily indicate that the development work has stopped. The work could potentially continue in the future as a follow-on IRAD; or used in collaboration or partnership with Academia, Industry and other Government Agencies.If you are interested in partnering with NASA, see the TechPort Partnerships documentation available on the TechPort Help tab. http://techport.nasa.gov/help

Images

Micro-Cone Array
Micro-Cone Array
(https://techport.nasa.gov/image/19073)

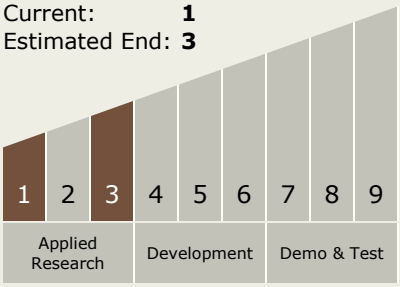
Links

A Path to Sub-micron Additive Manufacturing with Real Materials
(no url provided)

GSC-1785-1
(no url provided)

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **3**



Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.4 Manufacturing
    - TX12.4.1 Manufacturing Processes

Innovative Techniques for Micro-scale Additive Manufacturing for Sensors (μAM)

Completed Technology Project (2015 - 2017)

Project Website:

http://aetd.gsfc.nasa.gov/